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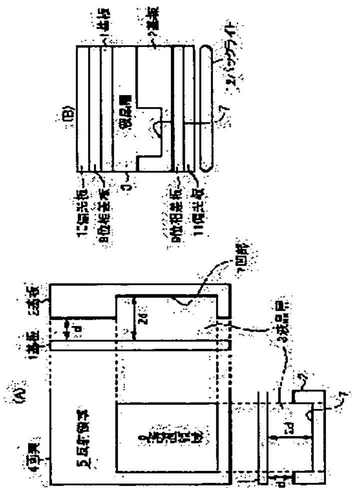
(71)Applicant : SONY CORP

(72)Inventor : CHISAKI MAKOTO
YAMAGUCHI HIDEMASA
KIDA YOSHITOSHI

(54) LIQUID CRYSTAL DISPLAY ELEMENT



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a liquid crystal display element of reflection and transmission joining type which shows high contrast and high transmitivity in a transmission display mode and further reconciles high contrast with high reflectivity even in a reflection display mode.

SOLUTION: The liquid crystal display element has a light-transmissive first substrate 1, a second substrate 2 which contains a reflection region 5 and a transmission region 6 and on which a pixel 4 is formed and liquid crystal 3 held by the first substrate 1 and the second substrate 2 joined to each other via a clearance. The liquid crystal 3 is aligned perpendicularly to the substrates 1, 2 in a voltage unapplied state. A pair of retardation films 8, 9 are arranged so as to hold the perpendicularly aligned liquid crystal 3 therebetween. A pair of retardation films 8, 9 have phase characteristics symmetrical to each other over a wavelength band of a visible region. More specifically, a pair of retardation films 8, 9 have lagging axes crossing each other and a crossing angle is set in a range of 90° ±10° . Relative deviation of phase difference between a pair of retardation films 8, 9 is restrained within ±30 nm.

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The first substrate which can penetrate light, and the second substrate with which the pixel including a reflective field and a transparency field was formed, It is the liquid crystal display component which has the liquid crystal held at the first substrate and the second substrate which were joined through the gap. Said liquid crystal It is the liquid crystal display component which the phase contrast plate of a pair is arranged so that the liquid crystal which is carrying out orientation perpendicularly to the substrate in the state of no electrical-potential-difference impressing, and which carried out orientation to this perpendicular may be inserted, and is characterized by the phase contrast plate of said pair having a symmetrical phase characteristic mutually over the wavelength range of a visible region.

[Claim 2] The phase contrast plate of said pair is a liquid crystal display component according to claim 1 characterized by for the lagging axis crossing mutually and setting the crossed axes angle as 90-degree range in which it is **10 degrees.

[Claim 3] The phase contrast plate of said pair is a liquid crystal display component according to claim 1 characterized by controlling relative gap of phase contrast within **30nm.

[Claim 4] Said liquid crystal is a liquid crystal display component according to claim 1 characterized by being set as the two times of the thickness of the part which has the thickness of the part in this transparency field in this reflective field.

[Claim 5] The liquid crystal display component according to claim 1 characterized by at least one of the two of said first substrate and the second substrate having the level difference in order to change the thickness of liquid crystal in this transparency field and this reflective field.

[Claim 6] Said level difference is a liquid crystal display component according to claim 5 characterized by consisting of a crevice which removed alternatively the insulator layer formed at least in one of the two of this first substrate and the second substrate, and formed it from this transparency field.

[Claim 7] Said liquid crystal is a liquid crystal display component according to claim 6 which orientation control is carried out using this crevice, and is characterized by switching from perpendicular orientation to multiaxial orientation according to electrical-potential-difference impression.

[Claim 8] Said crevice is a liquid crystal display component according to claim 6 characterized by having point symmetry nature to the geometric core.

[Claim 9] Said liquid crystal is a liquid crystal display component according to claim 1 characterized by adding the chiral agent and changing from perpendicular orientation to twist orientation according to electrical-potential-difference impression.

[Claim 10] Said liquid crystal is a liquid crystal display component according to claim 1 characterized by the part in a reflective field carrying out uniaxial orientation while the part which is in a transparency field according to electrical-potential-difference impression carries out multiaxial orientation.

[Claim 11] Said liquid crystal is a liquid crystal display component according to claim 10 characterized by being controlled by multiaxial orientation using the electrode slit or pillar-shaped object formed in this transparency field.

[Claim 12] Said pillar-shaped object is a liquid crystal display component according to claim 11

characterized by serving as the role of the spacer which regulates the gap of this first substrate and the second substrate uniformly.
[Claim 13] It is the liquid crystal display component according to claim 1 characterized by not performing rubbing processing, as for said transparency field while rubbing processing is performed, in order that said reflective field may carry out uniaxial orientation of this liquid crystal.
[Claim 14] The liquid crystal display component according to claim 1 characterized by making a surface state produce a difference in this transparency field and this reflective field, having, and making the orientation condition of liquid crystal change in this transparency field and this reflective field with selective irradiation of ultraviolet rays.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the liquid crystal display component currently broadly used for a notebook computer, a personal digital assistant, pocket mold VTR equipment, a digital still camera, etc. Also in a liquid crystal display component, it is invention about the liquid crystal display component which has the function of a reflective mold and a transparency mold. Having reflection and a transparency function means that it is the liquid crystal display component which is excellent in visibility also on indoor and the outdoors. Therefore, it is effective in liquid crystal display components, such as a personal digital assistant, Carrying VTR, and a digital still camera.
[0002]
[Description of the Prior Art] Various things as a flat display which can become irregular with an electrical signal and can rewrite the contents of a display are developed and produced. In recent years, as a spontaneous light type display device with prosperous researches and developments, OLED (Organic Light Emitting Diode), a plasma display, and FED (Field EmissionDisplay) are mentioned.
[0003] Indoors, since brightness is bright as compared with a liquid crystal display, such a spontaneous light type display is excellent in visibility. However, the direction of an outdoor environment sometimes becomes bright plentifully rather than the brightness of the display which carries out spontaneous light on the outdoors. Under such an environment, the visibility of a spontaneous light display device gets remarkably bad.
[0004] Moreover, a spontaneous light type display has the current which a drive takes, and the inclination for an electrical potential difference to become comparatively large and for power consumption to become large. If power consumption becomes large, it is not suitable for display devices, such as personal digital assistants, such as a cellular phone, and Carrying VTR, a digital still camera.
[0005] On the other hand, since a reflective mold liquid crystal display does not emit light but itself

displays it using outdoor daylight, visibility does not worsen under an outdoor environment bright enough, rather, brightness increases and visibility becomes good. Moreover, since there is nothing **** about a back light unlike a transparency mold liquid crystal display, the power consumption of a reflective mold liquid crystal display is also small the optimal to the display device of portable equipment.
[0006] However, although a reflective mold liquid crystal display is excellent in the visibility under a bright environment outdoors, when night comes and it becomes a dark environment, since light is not emitted, naturally it becomes dark and visibility also worsens. Since the brightness of a circumference environment is reflected in the brightness of a display as it is, a reflective mold liquid crystal display has it. [natural]
[0007] Then, the display device which is indoors excellent in visibility under any environments also on the outdoors as a display of a personal digital assistant etc. will be called for. As one of the display devices for attaining such a purpose, the liquid crystal display of a transparency reflective concomitant use mold is mentioned. Generally this transparency reflective concomitant use mold liquid crystal display is realized by the following two approaches.
[0008] It seems that blindness in one eye is in JP,59-218483,A. This is arranging the semi-permeable reflective film which consists of a thin metal membrane between a back light and a liquid crystal layer, and is the technique of serving both as transparency and reflective mode. However, theoretically, this mode can be compatible the transparent mode and reflective mode, and cannot optimize [mode]. That is, in order to use the same liquid crystal layer in the transparent mode and reflective mode, if the optical design which gave priority to the transparent mode is performed, the visibility in reflective mode will fall, and if the optical design of reflective mode priority is performed, the optical property at the time of transparency will worsen.
[0009] The 2nd is in JP,11-242226,A. This is dividing the reflective section and the transparency section within pixel area, and has realized reflective transparency concomitant use mode. Moreover, as the orientation condition of the liquid crystal of the transparency section and the reflective section is differed, the work which it may be about a good optical property at the reflection and transparency time is carried out.
[0010] Specifically, the thickness of the liquid crystal layer of the reflective section in a pixel and the transparency section is changed and optimized. That is, the reflective transparency section has attained a high reflection factor, permeability, and high contrast by setting the phase contrast at the time of the electrical-potential-difference ON in the wavelength of a visible region, and talent FU as the transparency section lambda / 2, and reflective section lambda / 4. That is, thickness of the liquid crystal of the transparency section is made into the two times of the thickness of the liquid crystal of the reflective section.
[0011] In Japanese Patent Application No. No. 359036 [nine to], and Japanese Patent Application No. No. 364247 [ten to], the guest host type which doped ** dichroism coloring matter as liquid crystal mode, ** twist orientation mode, ** homogeneous orientation mode, etc. are introduced. Emphasis is put on distinguishing between the thickness of a liquid crystal layer in a transparency field and a reflective field.
[0012]
[Problem(s) to be Solved by the Invention] Here, artificers inquired by changing the thickness of the liquid crystal layer of a transparency field and a reflective field, and making the panel in the liquid crystal mode of ****** as an experiment, respectively. ** considered to be the closest to especially practical use was examined in the detail.
[0013] ** It evaluated by producing the reflective transparency concomitant use mold liquid crystal device using guest host mode. Consequently, in order not to use a polarizing plate, it has checked that a reflection factor and permeability were high. However, since 2 color ratio of dichroic coloring matter was not enough, black level could not fully sink but it turned out that contrast is insufficient.
[0014] ** It evaluated by creating a panel with the application of twist orientation mode for the

'reflective transparency mold concomitant use liquid crystal dispplay component. When twist orientation processing was performed as a result, it turned out that control of the orientation of the liquid crystal in the boundary of a transparency field and a reflective field is difficult.

[0015] ** The homogeneous mode was evaluated. A liquid crystal molecule carries out orientation of the homogeneous mode to a horizontal (parallel) to a substrate. The direction of liquid crystal orientation in a field is controlled by rubbing processing etc. by the one direction in many cases. The direction of up-and-down rubbing has become in the antiparallel direction. When the level mode was used and a level difference is in the transparency section and the reflective section, there is an advantage from which a retardation is correctly obtained in proportion to the difference. That is, the difference of a retardation will also become half if thickness of the liquid crystal layer of the reflective section is made into the one half of the transparency section. In addition, a dielectric constant anisotropy uses a forward liquid crystal ingredient for the level mode.

[0016] About the panel which carried out the optical design of the reflective transparency concomitant use mold type to which level orientation of the liquid crystal was carried out so that it might become no MARI White mode, this invention persons have recognized that there is a fault as shown below, as a result of repeating prototype examination.

[0017] In the level mode, even if it impressed the ON state voltage of 5V to the liquid crystal panel, liquid crystal did not stand perpendicularly completely, but it became clear that a retardation remains. The retardation which remains is about 60mm.

[0018] Improvement in contrast can be aimed at by inserting a phase contrast plate equivalent to the retardation which remains in order to lower black level between polarizing plates. However, the retardation which remains is not fixed depending on cel thickness. Moreover, a phase contrast plate is [centrifugal processing is carried out, a polymer is produced and / variation] in a retardation value and is not fixed, either. Therefore, it is very difficult for both to negate each other completely.

[0019] Moreover, the wavelength dispersion of the refractive index of a liquid crystal ingredient and wavelength dispersion of a phase contrast plate cannot become equivalent completely.

[0020] In the level mode, artificers concluded that it was very difficult to acquire high contrast from these reasons.

[0021] Even if high contrast is acquired, it will cause the increase of cost that one phase contrast plate is needed in order to display black. The manufacture process becomes delicate and the cost of the small phase contrast plate of several 10mm in especially phase contrast is also high.

[0022] Next, it evaluated also about the angle of visibility. Orientation bearing of liquid crystal is controlled by rubbing processing etc. for level orientation mode by the one direction. Therefore, the direction where a liquid crystal molecule rises is an one direction.

[0023] If it sees from the direction where a liquid crystal molecule rises, the retardation of liquid crystal will become large. However, if it observes from the hard flow (180-degree rotation) of the bearing, the retardation of liquid crystal will become small. Thus, effectual retardations will differ greatly towards observing the uniaxial orientation mode in which a liquid crystal molecule inclines only in an one direction by electric field.

[0024] It cannot be overemphasized that the difference in the retardation in the direction to observe produces the difference in the "drawing" by the direction to see. That is, if the viewing-angle dependency of a retardation is large, naturally the angle-of-visibility property of the visibility of a panel will also worsen. Artificers checked that the angle-of-visibility property in the level mode was very bad theoretically also in the experiment. The principle is from the reason explained above. Thus, artificers have recognized it as the level mode not being suitable for a reflective transparency mold liquid crystal display component.

[0025] The technical problem which it is going to solve by this invention is high contrast and high permeability being shown in a transparency display mode, and reconciling high contrast and a high reflection factor also in a reflective display mode about a reflective transparency concomitant use mold

liquid crystal display component. Moreover, it is reconciling a wide-field-of-view angle in transparent mode reflective mode both.

[0026]

[Means for Solving the Problem] The following means were provided in order to solve the technical problem mentioned above. Namely, the first substrate with which this invention can penetrate light and the second substrate with which the pixel including a reflective field and a transparency field was formed, It is the liquid crystal display component which has the liquid crystal held at the first substrate and the second substrate which were joined through the gap. Said liquid crystal The phase contrast plate of a pair is arranged so that the liquid crystal which is carrying out orientation perpendicularly to the substrate in the state of no electrical-potential-difference impressing and which carried out orientation to this perpendicular may be inserted, and the phase contrast plate of said pair is characterized by having a symmetrical phase characteristic mutually over the wavelength range of a visible region. The lagging axis crosses mutually and, specifically, as for the phase contrast plate of said pair, the crossed axes angle is set as 90-degree range in which it is **10 degrees. Moreover, gap with phase contrast relative [the phase contrast plate of said pair] is controlled within **30nm.

[0027] Preferably, said liquid crystal is set as the two times of the thickness of the part which has the thickness of the part in this transparency field in this reflective field. For example, at least one of the two of said first substrate and the second substrate has the level difference, in order to change the thickness of liquid crystal in this transparency field and this reflective field. In this case, said level difference consists of a crevice which removed alternatively the insulator layer formed at least in one of the two of this first substrate and the second substrate, and formed it from this transparency field. Orientation control is carried out using this crevice, and said liquid crystal switches from perpendicular orientation to multiaxial orientation according to electrical-potential-difference impression. Said crevice has point symmetry nature to the geometric core.

[0028] Preferably, the chiral agent is added and said liquid crystal changes from perpendicular orientation to twist orientation according to electrical-potential-difference impression. Moreover, while the part which is in a transparency field according to electrical-potential-difference impression carries out multiaxial orientation of said liquid crystal, the part in a reflective field carries out uniaxial orientation of it. Moreover, said liquid crystal is controlled by multiaxial orientation using the electrode slit or pillar-shaped object formed in this transparency field. For example, said pillar-shaped object serves as the role of the spacer which regulates the gap of this first substrate and the second substrate uniformly. Preferably, as for said transparency field, rubbing processing is not performed while rubbing processing is performed, in order that said reflective field may carry out uniaxial orientation of this liquid crystal. It is good to make a surface state produce a difference in this transparency field and this reflective field depending on the case, to have, and to make the orientation condition of liquid crystal change in this transparency field and this reflective field with selective irradiation of ultraviolet rays.

[0029] Artificers concluded that the perpendicular orientation mode a liquid crystal molecule carries out [mode] orientation perpendicularly to a substrate was the optimal like this invention, as a result of examining various liquid crystal modes as a means to solve the technical problem mentioned above. A dielectric constant anisotropy has the description which intersects perpendicularly to the direction of a major axis of liquid crystal to a thing with a refractive-index anisotropy parallel [the liquid crystal ingredient used for this mode] to the direction of a major axis of liquid crystal. By optimizing the description and optical design of this perpendicular orientation, it turned out that high contrast, high permeability / high reflection factor, and a wide-field-of-view angle are acquired by both reflective display and transparency display. The design approach and principle are as above-mentioned. That is, it is important that the phase contrast plate of the pair which sandwiches the liquid crystal panel in perpendicular orientation mode has a symmetrical phase characteristic mutually over the wavelength range of a visible region. The lagging axis crosses mutually and, specifically, as for the phase contrast plate of a pair, the crossed axes angle is set as 90-degree range in which it is **10 degrees. Moreover,

'gap with phase contrast relative [the phase contrast plate of a pair] is controlled within **30nm.

[0030] It is desirable to perform the display in transparency and reflective mode by acquiring the cellular structure which made thickness of the liquid crystal layer of a transparency field especially twice [about] the thickness of the liquid crystal layer of a reflective field using perpendicular orientation. Since liquid crystal is carrying out perpendicular orientation of the time of electric-field OFF, there is no retardation. At the time of electric-field ON, since liquid crystal inclines, a retardation occurs. The level difference of cel thickness, a reflective field, and a transparency field is designed so that it may become lambda/2 in a transparency field and may become lambda/4 in a reflective field about the retardation value at this time.

[0031]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail with reference to a drawing. Drawing 1 is the mimetic diagram showing the fundamental configuration of the liquid crystal display component concerning this invention, (A) is orthogonal views and (B) is a sectional view. As shown in drawing 1 , the liquid crystal display component concerning this invention has the first substrate 1 which can penetrate light, the second substrate 2 with which the pixel 4 including the reflective field 5 and the transparency field 6 was formed, and the liquid crystal 3 held at the first substrate 1 and the second substrate 2 which were joined through the gap. Orientation of said liquid crystal 3 is perpendicularly carried out to substrates 1 and 2 in the state of no electrical-potential-difference impressing. The phase contrast plates 8 and 9 of a pair are arranged so that the liquid crystal 3 which carried out orientation to this perpendicular may be inserted. In addition, the polarizing plates 10 and 11 of a pair are further arranged on the outside. In addition, the back light 12 is arranged on the outside of a polarizing plate 11. Here, the phase contrast plates 8 and 9 of said pair are characterized by having a symmetrical phase characteristic mutually over the wavelength range of a visible region. The lagging axis crosses mutually and, specifically, as for the phase contrast plates 8 and 9 of said pair, the crossed axes angle is set as 90-degree range in which it is **10 degrees. Moreover, gap with phase contrast relative [the phase contrast plates 8 and 9 of said pair] is controlled within **30nm.

[0032] Preferably, said liquid crystal 3 is set as the two times of thickness d of the part which has the thickness of 2d of the part in this transparency field 6 in this reflective field 5. For example, at least one of the two of said first substrate 1 and the second substrate 2 has the level difference, in order to change the thickness of liquid crystal 3 in this transparency field 6 and this reflective field 5. In this case, said level difference consists of a crevice 7 which removed alternatively the insulator layer formed at least in one of the two of this first substrate 1 and the second substrate 2, and formed it from this transparency field 6. Orientation control is carried out using this crevice 7, and said liquid crystal 3 switches from perpendicular orientation to multiaxial orientation according to electrical-potential-difference impression. Said crevice 7 has point symmetry nature to the geometric core.

[0033] Preferably, the chiral agent is added and said liquid crystal 3 changes from perpendicular orientation to twist orientation according to electrical-potential-difference impression. Moreover, while the part which is in the transparency field 6 according to electrical-potential-difference impression carries out multiaxial orientation of said liquid crystal 3, the part in the reflective field 5 carries out uniaxial orientation of it. For example, said liquid crystal 3 is controllable to multiaxial orientation using the electrode slit or pillar-shaped object formed in this transparency field 6. In this case, said pillar-shaped object can serve as the role of the spacer which regulates uniformly the gap of this first substrate 1 and the second substrate 2. Preferably, as for said transparency field 6, rubbing processing is not performed while rubbing processing is performed, in order that said reflective field 5 may carry out uniaxial orientation of this liquid crystal 3. It is good to make a surface state produce a difference in this transparency field 6 and this reflective field 5 depending on the case, to have, and to make the orientation condition of liquid crystal change in this transparency field 6 and this reflective field 5 with selective irradiation of ultraviolet rays.

[0034] As shown in (B), in order to acquire high contrast in reflective mode, the method of using broadband lambda / 4 plate is effective as a phase contrast plate 8. It is the approach of losing the retardation of the liquid crystal layer 3 and displaying black only with a polarizing plate 10 and broadband lambda / 4 plate 8. lambda/4 plate 8 fulfills lambda/4 conditions in a broadband. Since it reflects in the reflective field of a substrate 2 and incident light passes 2 times lambda / 4 plate 8, 90 degrees of linearly polarized lights will rotate it. That is, outgoing radiation of the linearly polarized light which entered from the polarizing plate 10 will be carried out at all, and its black level can be depressed, and it can acquire high contrast. Artificers judged that it was effective to use this approach. That is, it considered as the structure which arranges a polarizing plate 10 and lambda/4 plate 8 at the front-face side of a liquid crystal display component. The liquid crystal layer 3 is perpendicular orientation. Since the liquid crystal molecule is carrying out perpendicular orientation of the perpendicular orientation at the time of electric-field OFF, there is no retardation. Therefore, reflective mode is NOMA reeve rack mode.
[0035] When reflective mode is designed in NOMA reeve rack mode, naturally it is necessary to design the transparent mode in NOMA reeve rack mode similarly. The following thing is needed in order to make the transparent mode into NOMA reeve rack mode. Similarly the transparent mode shows the configuration method of an effective polarizing plate and a phase contrast plate to (B) of drawing 1 . It is required to arrange a phase contrast plate with the same optical effectiveness as the phase contrast plate 9 which rotates 90 degrees, and arranges lambda/4 plate 8 arranged on the panel front face and the completely equivalent phase contrast plate 9 to a back-of-panel side, or is obtained by 90 degrees rotating. This becomes clear from analyzing the propagation condition of the outgoing radiation light from a back light 12 in the structure shown in (B) of drawing 1 .
[0036] Propagation of the light in the transparency field 6 is analyzed. The light which came out of the back light 12 is changed into the linearly polarized light by the polarizing plate 11. Next, it is changed into the circular polarization of light by lambda / 4 phase-contrast plate 9 on the back. Next, when passing the liquid crystal layer 3, since liquid crystal is carrying out perpendicular orientation, there is no phase contrast and a polarization condition does not change. Next, the phase contrast plate 8 by the side of the front face which 90 degrees of opticals axis rotated to the phase contrast plate 9 is passed. At this time, the circular polarization of light is changed into the linearly polarized light, and that polarization direction takes the completely same direction as the time of passing a polarizing plate 11. Since the polarizing plate 11 and the polarizing plate 10 lie at right angles, light does not penetrate a polarizing plate 10 but shows black. The black level at this time is equivalent to the time of carrying out cross Nicol's prism arrangement of the polarizing plate, the transmitted light reinforcement of black level is very small, and high contrast can be easily acquired at the time of the transparent mode.
[0037] In addition, even if it makes the phase contrast plates 8 and 9 of a pair, and the polarizing plates 10 and 11 of a pair into parallel, without making 90 degrees intersect perpendicularly respectively as mentioned above, a drive with NOMA reeve rack mode is possible. The principle is two lambda / 4 phase-contrast plates, is forming lambda/2 plate, and can be realized by rotating 90 degrees of linearly polarized lights which carried out incidence. However, it is very difficult to fill lambda/2 conditions with two phase contrast plates in a visible region wavelength field. The way made to intersect perpendicularly as mentioned above can acquire a dark condition easily rather than arranging in parallel.
[0038] When rectangular arrangement of the phase contrast plate of a pair is carried out, lambda / 4 phase-contrast plate 8, and the lambda / 4 phase-contrast plate 9 need to have completely equivalent phase contrast in the wavelength range of a visible region. It is that lambda / 4 phase-contrast plate 8, and the lambda / 4 phase-contrast plate 9 negate each other in the light of all wavelength, and is because black is displayed.
[0039] Since lambda / 4 phase-contrast plate 8 by the side of a front face are used also in reflective mode, it is required to be lambda/4 plate of a broadband. But the configuration of an ideal phase contrast plate is structure shown below. That is, it is the optical axis of having lambda/4 of phase

'contrast, and the lambda / 4 phase-contrast plates 8 and 9 forming lambda / 4 phase-contrast plates 8 and 9, and arranging the include angle of 90 degrees. [the whole visible region wavelength]

[0040] Even if lambda / 4 phase-contrast plates 8 and 9 may be optically uniaxial phase contrast plates and are optically biaxial phase contrast plates, they are not cared about. However, it is required to fulfill the above Nijo affairs about the phase contrast within a field.

[0041] In order to extend an angle of visibility, the refractive-index anisotropy other than lambda / 4 phase-contrast plates 8 and 9 may arrange the phase contrast plate which is negative. However, it is required to fulfill the above conditions similarly about the phase contrast within a field.

[0042] In addition, in the transparency field 6, if an electrical potential difference is impressed, liquid crystal 3 will shift to multiaxial orientation from perpendicular orientation, and will function as lambda / a 2 phase-contrast plate. Therefore, 90 degrees rotates, and the incidence linearly polarized light turns into the outgoing radiation linearly polarized light, and passes the polarizing plate 10 by the side of a front face. Therefore, a white display is obtained. Moreover, in the reflective field 5, if an electrical potential difference is impressed, liquid crystal 3 will shift to uniaxial orientation from perpendicular orientation, and will function as lambda / a 4 phase-contrast plate. Since light goes in a reflective field, after all, liquid crystal 3 becomes lambda / 2 phase-contrast plate, and equivalence both ways as well as a transparency field, and 90 degrees rotates, the incidence linearly polarized light turns into the outgoing radiation linearly polarized light, and it passes the polarizing plate 10 by the side of a front face. Therefore, a white display is obtained. It is set as the two times of the thickness of the part which has the thickness of the part which liquid crystal 3 has in the transparency field 6 like mentioned above in the reflective field 5, and according to electrical-potential-difference impression, it functions as lambda / a 2 phase-contrast plate, and functions as lambda / a 4 phase-contrast plate according to electrical-potential-difference impression in the reflective field 5 in the transparency field 6.

[0043] Especially artificers examined the effective liquid crystal orientation approach, in order to extend the angle-of-visibility property at the time of transparency. Consequently, as shown in drawing 2 , perpendicular orientation is taken in electric-field the condition of not impressing, electric field are impressed, and a liquid crystal molecule is made to incline. It turned out that the inclination direction is equally distributed in 360-degree side, and an angle of visibility can be sharply expanded by considering as the so-called radiation orientation or multiaxial orientation. The angle of visibility in both the modes can be raised by leaps and bounds by controlling the orientation of the reflective section and the transparency section in this way. It checked that the thing of effectiveness which described especially the orientation of the transparency section above and to control like was larger than the reflective section. Even if the reflective section has the uniform inclination direction, it is because wide-field-of-view cornification is possible in installing a dispersion reflecting plate etc.

[0044] It has already inquired, for example, the technique which controls the direction of orientation of liquid crystal in the various directions is Y.Toko. et.A1., S1D'93 Digest of There are Tech.Papers and 24 (1993) 622. In TN mode, it is the technique characterized by giving distribution in the direction of orientation of liquid crystal by not performing rubbing processing.

[0045] It also sets to perpendicular orientation and is T.Yamamoto as same technique. et.A1., SID'91 Digest of Tech.Papers, 22 (1991) 1081, etc. are reported. This technique raises an angle of visibility by making a liquid crystal molecule incline in a radial using electric field.

[0046] The technique of raising permeability is reported improving an angle of visibility by distributing 360 degrees of orientation bearings of liquid crystal in all the directions in perpendicular orientation mode. Y. Iwamoto.et.al SID'00 Digest of It is Tech.Papers and 31 (2000) 902. By this report, permeability is raised by arranging lambda/4 plate before and after a polarizing plate, making an angle of visibility large by distributing the direction of liquid crystal orientation over a radial by electric field. A principle is because permeability stops being dependent on orientation bearing of liquid crystal by introducing lambda/4 plate. There is the description which light penetrates also in the field as for which liquid crystal carried out orientation to coincidence in the same direction as a polarizing plate.

[0047] Also in this invention, lambda/4 plate needs to be arranged in a transparency viewing area. Therefore, Y.Iwamoto.et.al mentioned above SID'00 Digest of It is possible to combine Tech.Papers and the technique of 31 (2000) 902. That is, it is possible for it to be compatible in improvement in an angle of visibility and high permeability by distributing the orientation condition of the liquid crystal molecule of a transparency field in the direction of all by a certain approach.
[0048] In addition, there is no need of making 360-degree bearing distributing the direction of orientation of liquid crystal, and the same effectiveness is acquired even if it generally divides into multiple spindles, such as a 2-way, three directions, and four directions.
[0049] Various approaches can be proposed as an approach of making the liquid crystal molecule of a transparency viewing area inclining in all the directions at the time of electric-field ON. It is the approach that artificers think especially that it is effective prepares a level difference in the reflective section and the transparency section, and it introduces structure like a slot also in it. As for this structure, it is desirable to fulfill the conditions which set the thickness of the liquid crystal in a transparency field as coincidence at the two times of the thickness of the liquid crystal in a reflective field.
[0050] Structure like drawing 3 can be considered as concrete structure. In addition, in order to make an understanding easy, the corresponding number is given to the operation gestalt shown in drawing 1 , and the corresponding part. As for the configuration of a crevice 7, in the case of this operation gestalt, it is desirable to have symmetric property to the center of gravity of the transparency section 6. That is because it is easy to control orientation bearing of liquid crystal 3 to a radial toward a core from a center of gravity. Therefore, the crevice 7 which consists of a slot shown in drawing 3 is formed. When there is a crevice 7, since orientation of the liquid crystal molecule is met and carried out to the tilt angle of the slot, it is the the best for the control for making a radial incline at the time of electric-field impression.
[0051] It is desirable to arrange a nucleus which carries out induction of the orientation of a radial at the time of electric-field ON in the location of the transparency section 6 which is mostly equivalent to a center of gravity. Whichever holding liquid crystal of a substrate may have nuclear arrangement. What carried out pattern NINGU of the electrode and removed it as a nucleus, and the thing which produced the projection 13 at the FOTORISO process with the flattening film etc. like illustration may be used. In addition, when producing a nucleus with a projection, it is also possible to serve as spacer ability for the projection to hold between two substrates 1 and 2.
[0052] It is clear from the following examples that a wide-field-of-view angle and high permeability are realizable in the transparent mode by performing orientation control of the liquid crystal in the transparency field of the reflective transparency concomitant use mold liquid crystal device which artificers propose as mentioned above.
[0053] The panel cross-section structure of an example 1 is first shown in drawing 4 . In addition, in order to make an understanding easy, the corresponding number is given to the operation gestalt shown in drawing 1 , and the corresponding part. This liquid crystal display component consists of two sheets, the color filter substrate 1 and the TFT (Thin Film Transistor) substrate 2. The structure crowded on both sides of liquid crystal 3 through a spacer 22 is taken between two substrates 1 and 2.
[0054] The TFT component 21 for carrying out the active drive of the pixel 4 is formed in the TFT substrate 2. Moreover, the gate line G and signal line S linked to the TFT component 21 are formed. Patterning of the photopolymer transparent as a flattening layer 23 is carried out on TFT21. The thickness of the flattening film 23 is about 2.0 micrometers. Pattern NINGU of the flattening film 23 is carried out so that it may not remain in the transparency field 6. The transparency field 6 has the crevice 7 which takes the configuration of a forward octagon. On the flattening film 23, ITO which is a transparent electrode 24 is formed throughout the pixel. Structure with the light-scattering effectiveness of concavo-convex structure is formed in the reflective field 5 of the pixel on a transparent electrode 24 by pattern NINGU with the photopolymer. In the reflective field 5, the aluminum

'metal membrane 25 which serves both as an electrode and a reflecting plate is formed on concavo-convex structure. With the pixel structure by the side of this TFT, patterning of the drain electrode of a transistor, and ITO and aluminum is carried out so that it may become the structure where contact is taken physically.

[0055] The color filter 29 of red (R), green (G), and blue (B) is formed in the color filter (CF) substrate 1 in the shape of a SUTORA life. On the color filter 29, the transparent electrode 27 of 100mm thickness is formed by ITO. The conic projection 13 was formed on ITO at the CF side substrate 1. Creation of projection 13 made the photopolymer from photolithography processing, and was crowded. By using a photosensitive ingredient as a spin coat, after carrying out exposure development, it considered as the structure near a cone by mid baking at 180 degrees C. The magnitude of projection 13 set height to 1.5 micrometers in the radius of 5 micrometers. When it piles up, the projection 13 has been arranged so that it may be located at the core of the transparency field 6 of the octagon of the TFT substrate 2.

[0056] the TFT substrate 2 and the CF substrate 1 -- the perpendicular orientation film 26 and 28 -- an orientation agent -- a film is produced by the 50mm printing approach by JALS-2021 (JSR, Inc.). Then, it heat-treats by O 1 BUN for 180-degree-C 1 hour. When the TFT substrate 2 and the CF substrate 1 pile up after heat treatment, rubbing processing of the orientation film 26 and 28 is performed in the bearing in which each other direction of rubbing becomes antiparallel.

[0057] Electric conduction agent application for common electrode connection was performed to the TFT substrate 2 which performed rubbing processing, and the 2.0-micrometer acrylic spacer 22 was sprinkled. The sealant was applied to the CF substrate 1. The TFT substrate 2 and the CF substrate 1 are piled up, and it is left for 2 hours and made to paste up at 13.3Pa and 120 degrees C. After superposition, the thickness of the transparency section 6 checked [4.0 micrometers and the reflective section 5] that it was 2.0 micrometers.

[0058] Liquid crystal 3 is poured into an empty panel by the vacuum impregnation approach. The poured-in liquid crystal 3 is a liquid crystal ingredient negative in a dielectric constant anisotropy. A dielectric constant anisotropy (deltaepsilon) is -5.5. A refractive-index anisotropy (deltan) is 0.08.

[0059] Then, the phase contrast plate and the polarizing plate were stuck on the panel. It has a laminated structure which piled up a polarizing plate 10 (observation side), the phase contrast plate 81, the phase contrast plate 82, the liquid crystal layer 3, the phase contrast plate 91, the phase contrast plate 92, and the polarizing plate 11 (back light side) sequentially from the top. lambda/4 wavelength plate consists of the phase contrast plates 81 and the phase contrast plates 82 which are located in an observation side. Moreover, other lambda/4 wavelength plates consist of phase contrast plates 91 and 92 by the side of a back light.

[0060] Drawing 5 makes a table panel structure of the example 1 shown in drawing 4 , and expresses it typically. The liquid crystal display component concerning an example 1 has a laminated structure which piled up a polarizing plate (observation side), the phase contrast plate 1, the phase contrast plate 2, the liquid crystal layer, the phase contrast plate 3, the phase contrast plate 4, and the polarizing plate (back light side) sequentially from the top so that it may illustrate. lambda/4 wavelength plate consists of the phase contrast plates 1 and the phase contrast plates 2 which are located in an observation side. Moreover, other lambda/4 wavelength plates consist of phase contrast plates 3 and 4 by the side of a back light. The phase contrast plate 1 by the side of observation and the phase contrast plate 4 by the side of a back light correspond mutually, and phase contrast is equal to 270nm respectively. Moreover, the phase contrast plate 2 and the phase contrast plate 3 correspond, and phase contrast is 140nm and is equal, respectively. The lagging axis of the phase contrast plates 1 and 4 which correspond mutually lies at right angles at 90 degrees. Similarly, the lagging axis of the phase contrast plates 2 and 3 also lies at right angles mutually. In addition, the absorption shaft lies at right angles also to the polarizing plate by the side of observation, and the polarizing plate by the side of a back light mutually.

[0061] In the panel of the starting structure, the measurement result in the transparent mode was also shown in drawing 5 , and the contrast as which the permeability at the time of a black display expresses

a ratio·with the time of a white display in 2.0% was 150. In the transparency display mode of this example, as for the phase contrast plate 1, the phase contrast plate 4 and the phase contrast plate 2, and the phase contrast plate 3, phase contrast is equal, the lagging axis lies at right angles, and the permeability of a dark condition becomes small most, and contrast becomes large.

[0062] In addition, the optical property of the reflective transparency mold concomitant use mold liquid crystal display component concerning an example 1 measured according to the definition shown below. The reflection factor and contrast at the time of reflective mode were measured by the definition shown below. That is, from the panel normal, the reflection factor carried out incidence of the parallel light of 30 degrees, and was defined with the reflectivity of the direction of a normal. however, the reflectivity of 100% of reflection factors -- the reflection factor of a standard white plate (MgO) -- ** -- it carried out. The value broken by the reflection factor when not impressing the reflection factor at the time of 4.5V impression defined the contrast in reflective mode. The permeability of the transparent mode, and contrast and an angle of visibility were measured by the definition shown below. The value which broke the transmitted light reinforcement after the liquid crystal panel transparency at the time of 4.5V impression by back light light reinforcement defines the transmission of the transparent mode. Contrast is the value which broke the transmitted light reinforcement at the time of 4.5V impression by transmitted light reinforcement in electrical-potential-difference the condition of not impressing.

[0063] Drawing 6 expresses typically the arrangement relation of the each phase plate and polarizing plate which were shown in drawing 5 . The dual leadership arrow head shown in drawing 6 expresses bearing of the lagging axis of a Gentlemen phase differential plate, and the absorption shaft of a polarizing plate. This bearing is counterclockwise measured on the basis of the horizontal axis, and that include-angle numeric value is summarized in the table of drawing 5 . The lagging axis of the phase contrast plate 1 which corresponds mutually, and the phase contrast plate 4 lies at right angles, and the lagging axis of the phase contrast plate 2 and the phase contrast plate 3 also lies at right angles mutually so that clearly from the mimetic diagram of drawing 6 . Moreover, the absorption shaft of the polarizing plate 1 by the side of observation and the polarizing plate 2 by the side of a back light also lies at right angles mutually. In addition, the direction of rubbing by the side of a TFT substrate and the direction of rubbing by the side of CF substrate have antiparallel relation.

[0064] Drawing 7 summarizes the configuration of an example 2 in a table. The example 2 has the same configuration fundamentally with the example 1 which is the ideal structure shown in drawing 5 . A different point is having changed the lagging axis of the phase contrast plate 1 by 2-degree unit among 100 degrees - 120 degrees.

[0065] The optical property in the transparent mode of an example 2 was measured on this condition. The result is shown in drawing 8 . To the appearance mentioned above, by the example 2, the lagging axis of the phase contrast plate 1 was changed to 2-degree unit among 100 degrees - 120 degrees, and permeability and contrast are measured at each include angle.

[0066] Drawing 9 graph-izes the measurement result of the permeability shown in drawing 8 . The lagging axis of the phase contrast plate 1 is taken along an axis of abscissa, and permeability is taken along the axis of ordinate. When the lagging axis of the phase contrast plate 1 is set as 110 degrees which is in an ideal condition so that clearly from a graph, permeability increases to 2%. Permeability falls as it will shift from now on.

[0067] Drawing 10 graph-izes the measurement result of the contrast of the example 2 shown in drawing 8 . The lagging axis of the phase contrast plate 1 is taken along an axis of abscissa, and contrast is taken along the axis of ordinate. When the lagging axis of the phase contrast plate 1 is set as 110 degrees which is in an ideal condition, contrast becomes the highest at 150. Generally, 10 is considered to be the need for contrast at the lowest. Therefore, the lagging axis of a phase contrast plate is effective in 100 degrees - 120 degrees. When based on 110 degrees, if a gap of a lagging axis is settled in the range of **10 degrees, it will be satisfactory practical.

[0068] Drawing 11 makes panel structure of an example 3 a table. Fundamentally, although it was the

'same as that of an example 1, the phase contrast of the phase contrast plate 2 was changed among 110nm - 170nm, and the optical property of the transparent mode was measured.

[0069] Drawing 12 expresses the measurement result of the optical property in the transparent mode of an example 3.

[0070] Drawing 13 graph-izes change of permeability among the measurement results shown in drawing 12 . The phase contrast of the phase contrast plate 2 is taken along an axis of abscissa, and permeability is taken along the axis of ordinate. When the phase contrast of the phase contrast plate 2 is 135nm, the permeability in a black display mode becomes the highest, and permeability becomes low as it separates from a peak. However, the change has stopped at the range small on the whole.

[0071] Drawing 14 graph-izes change of contrast among the measurement results of the example 3 shown in drawing 12 , takes the phase contrast of the phase contrast plate 2 along an axis of abscissa, and has taken contrast along the axis of ordinate. Contrast becomes the highest, when the phase contrast of the phase contrast plate 2 is 140nm which is in an exactly ideal condition so that clearly from a graph. Although about ten are [like] required also at the lowest, the preferably larger thing of contrast mentioned above than 20 is good. In this case, the phase contrast of the phase contrast plate 2 sees practical and is enough if it enters among about 110nm - 170nm. If based on 140nm of a center, a gap of phase contrast is permissible to **30nm.

[0072] In order to compare an optical property in the perpendicular orientation mode concerning this invention, and homogeneous orientation mode, the reflective transparency concomitant use mold liquid crystal display component of homogeneous orientation was made as an experiment as an example of reference. The optical configuration is summarized in front drawing of drawing 15 .

[0073] Since the production process is almost the same as what was shown in the example 1, only difference indicates it. The projection by the side of CF substrate first formed in the example 1 was not prepared in homogeneous orientation mode. Next, the orientation film which carries out level orientation instead of the perpendicular orientation film was used for orientation processing. Specifically, SE7492 (Nissan chemistry) was used. The direction of rubbing was made into the same direction as what is shown in an example 1. Moreover, a dielectric constant anisotropy is forward and, as for the liquid crystal to pour in, deltan used the thing of 0,075. The superposition of a substrate was assembled using the 2.0-micrometer spraying spacer. The configuration of a phase contrast plate and a polarizing plate is as having been shown in drawing 15 .

[0074] The optical property of the example of reference was measured on the same conditions as an example 1. In the transparent mode, permeability was 2.0 and contrast was 80. As compared with the example of reference of homogeneous orientation, it has checked that the direction of the perpendicular orientation mode of an example 1 was excellent in contrast so that clearly from the result of ****.

[0075] Then, the gestalt of an example 4 is shown in drawing 16 . In addition, in order to make an understanding easy, the corresponding reference number is given to the example 1 and the corresponding part. In the example 1, the structure which removed the transparent electrode 27 by etching in the shape of a circle was used instead of the projection prepared in the CF side substrate. This ITO slit 50 induces the same effectiveness as the projection of an example 1. When the liquid crystal orientation condition at the time of electric-field impression of the transparency field 6 was checked, it checked that liquid crystal was carrying out orientation to the radial the core [an ITO slit]. Thus, the same approach as an example 1 estimated the optical property of the produced liquid crystal display component. In the transparent mode, permeability was 2.0 and contrast was 150. It checked that the same result as an example 1 was obtained.

[0076] Then, the gestalt of an example 5 is shown in drawing 17 . In addition, in order to make an understanding easy, the corresponding reference number is given to the example 1 and the corresponding part. It replaced with the projection prepared in the example 1, and the cross-joint-like rib structure 13 was established on ITO. When the liquid crystal orientation condition at the time of electric-field impression of the transparency field 6 was checked, it checked that liquid crystal was

carrying out orientation to the radial the core [the cross-joint-like rib structure 13]. Thus, the same approach as an example 1 estimated the optical property of the produced liquid crystal display component. In the transparent mode, permeability was 2.0 and contrast was 150. It checked that the same result as an example 1 was obtained.

[0077] In orientation down stream processing performed in the example 1, the liquid crystal display component was produced by the case where only a TFT substrate performs rubbing processing, the case where only the CF side substrate performs rubbing processing, and the case where rubbing processing is not performed to both substrates, and it considered as the example 6. When only a single-sided substrate performed rubbing processing, the orientation condition of liquid crystal was almost the same as the example 1. When not both substrates performed rubbing processing, it has checked carrying out orientation of the orientation condition of a transparency field to the radial which excelled the example 1 in symmetric property more. The orientation of a reflective field is also effective in the irregularity of a scattered plate making liquid crystal orientation random, and the angle of visibility in reflective mode also became large. In spite of having become random orientation, there was little decline in a reflection factor. This is because the effectiveness of this invention is functioning also in reflective mode. Thus, the same approach as an example 1 estimated the optical property of the produced liquid crystal display component. In the transparent mode, permeability was 2.0% and contrast was 150. It checked that the same result as an example 1 was obtained.

[0078] The gestalt of an example 7 is shown in drawing 18 . In addition, in order to make an understanding easy, the corresponding reference number is given to the example 1 and the corresponding part. It replaced with the projection on CF substrate formed in the example 1, and the spacer column 60 with a height of about 4.0 micrometers was formed. As for the transparency field 6, the cross-section configuration set the diagonal line to 8 micrometers with the forward octagon. This CF substrate 1 and the TFT substrate 2 were stuck without the spacer spraying process. Consequently, as for about 4.0m and the reflective section 5, cel thickness found that the transparency section 6 was about 2.0 micrometers like the spraying spacer. When the orientation condition of the liquid crystal of the transparency field 6 was observed to coincidence at the time of electric-field impression, it also checked that the orientation of liquid crystal was controlled by the radial centering on the spacer column 60. That is, in this example, while the projection 60 functioned as a spacer which maintains between the TFT substrate 2 and the CF substrate 1, it has checked functioning also as a nucleus for carrying out orientation of the transparency field 6 to a radial. Thus, the same approach as an example 1 estimated the optical property of the produced liquid crystal display component. In the transparent mode, permeability was 1.85% and contrast was 150. It checked that the same result as an example 1 was obtained. In addition, although the permeability at the time of electrical-potential-difference ON becomes small a little in order that the part of the spacer column 60 may not contribute to permeability, other parameters are equal as compared with an example 1.

[0079] The gestalt of an example 8 is shown in drawing 19 . The process of orientation processing of an example 1 was changed and orientation control of liquid crystal was performed by technique as shown below. Namely, a TFT substrate and CF substrate print JALS2021 (JSR) as perpendicular orientation film, and are baked at 180 degrees for 1 hour. After that, the ultraviolet rays which polarized are irradiated alternatively at the orientation film. The mercury lamp was used for the ultraviolet ray lamp. Polarization of ultraviolet rays was realized by passing that to which the laminating of the dielectric multilayers was carried out. Polarization ultraviolet rays were irradiated from bearing which makes the include angle of 45 degrees to a substrate normal. Moreover, the direction of radiation which drawing 19 defines was made to become in the same direction as the direction of rubbing of an example 1. Polarization ultraviolet rays irradiated only the reflective section field alternatively by using a mask. The irradiated ultraviolet-rays energy is about 1 [J/cm2] in 365nm. By performing the above-mentioned orientation process, orientation processing was able to be performed only in the reflective section. Both the substrates that performed orientation processing to the such rule were stuck, the liquid crystal

display component was produced, and the same evaluation as an example 1 was performed. In the transparent mode, permeability was 2.0 and contrast was 150. Although the optical property was almost the same as the example 1, the transparency field checked to homogeneity that orientation division was carried out with the optical microscope as compared with the example 1.

[0080] The liquid crystal which mixed chiral material as an example 9 was used. In the example 1, only the liquid crystal to pour in was changed and the panel was made as an experiment. Although the liquid crystal ingredient itself used the same thing, it mixed the chiral agent into liquid crystal, and adjusted the chiral pitch to 50 micrometers. This liquid crystal was poured in in the same process as an example 1, it mounted like the example 1, and the optical property was evaluated. In the transparent mode, permeability was 2.0 and contrast was 150. The optical property checked that an angle-of-visibility property was excellent as compared with an example 1, as a result of observing by human being's eyes, although there were not an example 1 and inferiority.

[0081]

[Effect of the Invention] By using this invention, the effectiveness taken below in a reflective transparency mold concomitant use liquid crystal display component is expectable.

1. In a reflective viewing area, it becomes possible to be compatible in high contrast and a high reflection factor.

2. In a transparency viewing area, it becomes realizable [high contrast, high permeability, and a wide-field-of-view angle].

3. The design of a phase contrast plate is simple, and the number of sheets of a phase contrast plate can reduce to a minimum of two sheets, and becomes possible [producing a panel cheaply]. In addition, a phase plate may be two or more pairs, without being restricted to a pair.

4. Since it is in NOMA reeve rack mode of perpendicular orientation, it is not necessary to perform protection-from-light processing of the cure against contrast. A numerical aperture becomes large because protection from light is unnecessary, and a high reflection factor and high permeability can be realized.

5. Perpendicular orientation mode has the description that the threshold of an electrical-potential-difference 1 transmission curve is large. Therefore, there is an advantage of being hard to recognize a cross talk.

6. It is also possible to skip a rubbing process and rubbing washing can also be excluded. While the processes of two processes are reduced and baton time amount decreases, the yield fall by rubbing can also be prevented. Dust generating by rubbing can also be prevented to coincidence.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the mimetic diagram showing the fundamental configuration of the liquid crystal display component concerning this invention.
[Drawing 2] It is the mimetic diagram showing the liquid crystal orientation condition of the liquid crystal display component shown in drawing 1 .
[Drawing 3] It is the mimetic diagram showing the modification of the liquid crystal display component shown in drawing 1 .
[Drawing 4] It is the mimetic diagram showing the example 1 of the liquid crystal display component concerning this invention.
[Drawing 5] It is front drawing showing the structure of an example 1.
[Drawing 6] It is the mimetic diagram showing the structure of an example 1.
[Drawing 7] It is front drawing showing the configuration of an example 2.
[Drawing 8] It is front drawing showing the measurement result of the optical property of an example 2.
[Drawing 9] It is the graph which shows the measurement result of the optical property of an example 2.
[Drawing 10] It is the graph which shows the measurement result of the optical property of an example 2.
[Drawing 11] It is front drawing showing the structure of an example 3.
[Drawing 12] It is front drawing showing the measurement result of an example 3.
[Drawing 13] It is the graph which shows the measurement result of an example 3.
[Drawing 14] It is the graph which shows the measurement result of an example 3.
[Drawing 15] It is front drawing showing the optical design of the example of reference.
[Drawing 16] It is the mimetic diagram showing other examples.
[Drawing 17] It is the mimetic diagram showing other examples.
[Drawing 18] It is the mimetic diagram showing other examples.
[Drawing 19] It is the mimetic diagram showing other examples.
[Description of Notations]
1 [... A pixel, 5 / ... A reflective field, 6 / ... A transparency field, 7 / ... A crevice, 8 / ... A phase contrast plate, 9 / ... A phase contrast plate, 10 / ... A polarizing plate, 11 / ... A polarizing plate, 12 / ... Back light] ... A substrate, 2 ... A substrate, 3 ... A liquid crystal layer, 4

[Translation done.]